Electronic Services - Los Angeles
M12885X

# INSTRUCTION BOOK

for

# MODEL DM-3

# PEAK READING DEVIATION METER

Gertsch

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**GERTSCH PRODUCTS, Inc.**

3211 SOUTH LA CIENEGA BOULEVARD, LOS ANGELES 16, CALIFORNIA • UPTON 0-2761 - VERMONT 9-2201

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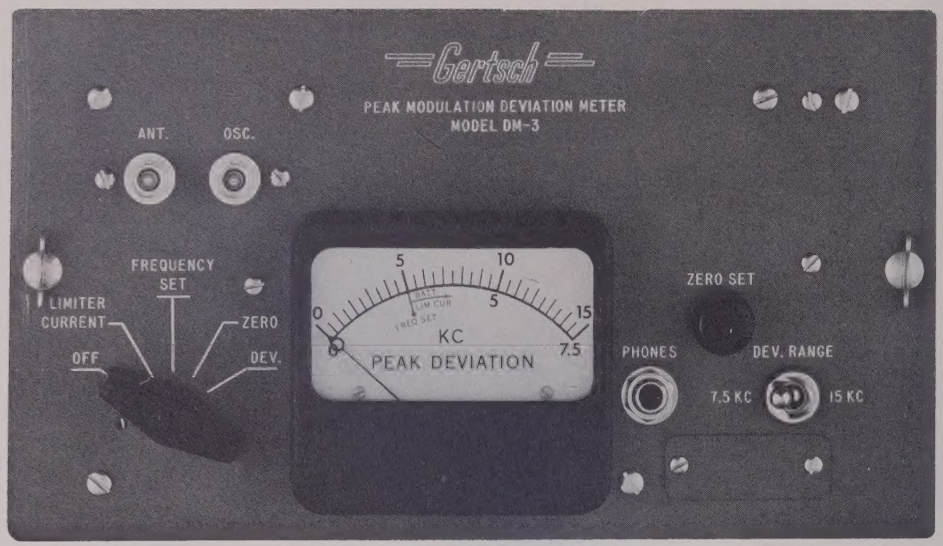
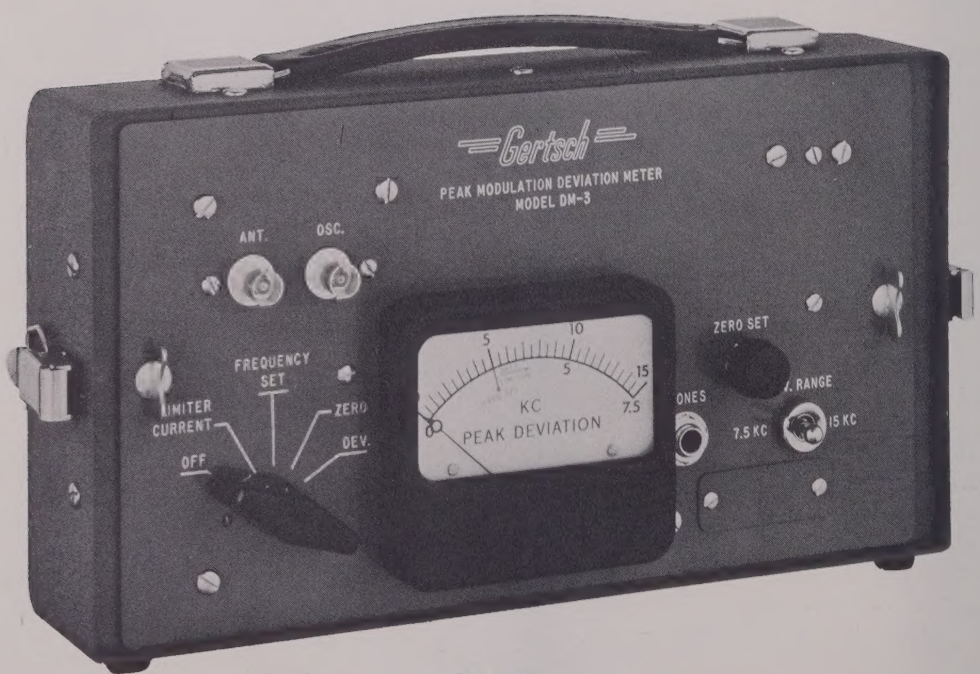



DM-3




DM-3C

FIGURE 1

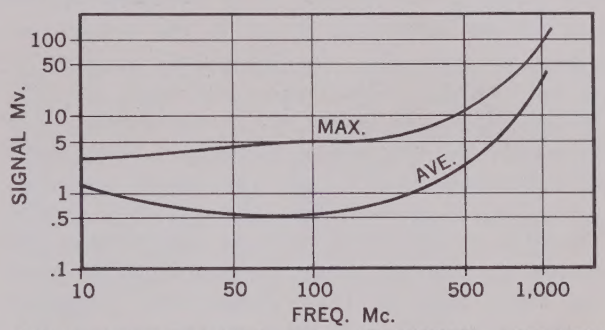
# SECTION I
# GENERAL DESCRIPTION

This instruction book contains information on the DM-3 Deviation Meter in sufficient detail to permit the operation, adjustment and maintenance that may be encountered.

The instrument is available in three models which differ only in mechanical configuration. The basic DM-3 was designed for use with the Gertsch Models FM-3/PS-3 and FM-7 Frequency Meters. Space and mounting provisions are allotted within the aforementioned frequency meters for the installation of the DM-3. The DM-3C is the basic DM-3 supplied with carrying case and lid. The DM-3R is the basic DM-3 mounted on a standard 19 inch rack panel.

### PERFORMANCE CHARACTERISTICS AND SPECIFICATIONS

1. Frequency Range: 20-1000MC
2. Accuracy: ±5% of full scale
3. Ranges: 15KC and 7.5KC full scale (selected by front panel switch)
4. Sensitivity: See chart below
5. Audio Output: Modulation available at phone jack on front panel
6. Power Requirements: 115 VAC, 60 cps
7. Size: DM-3 - 10½" x 6" x 3"
   DM-3C - 12" x 7" x 4"
   DM-3R - 19" panel x 7" high x 3"



SIGNAL INPUT REQUIRED FOR SATISFACTORY OPERATION

# SECTION II
# OPERATION

### 1. GENERAL

The DM-3 is a superhetrodyne FM receiver without an internal local oscillator. An FM-3, FM6 or FM-7 Frequency Meter or other source of stable signals in the desired frequency range is required to act as local oscillator. Tuning of the high frequency oscillator of the FM-3, FM-6 or FM-7 is accomplished by reference to meter readings on the DM-3. Since the DM-3 mixer system is untuned, there are two responses for every signal. When the FM-3, FM-6 or FM-7 is tuned above the frequency of the measured signal, high side deviation will be measured by the DM-3. When the FM-3, FM-6 or FM-7 is tuned below the measured signal, the DM-3 will indicate low side deviation.

### 2. COUPLING

It is necessary to couple sufficient signal into the DM-3 to produce adequate limiter current as indicated by the meter when the switch is in the LIM. CURR. position. Damage to the crystal mixer might occur if large amounts of power are coupled into the DM-3. Between these limits, there is a broad range of signal level which will produce satisfactory results with the DM-3. It is normally a safe and desirable practice to increase coupling until the meter shows no further increase in limiter current because of I.F. saturation. Using the small antenna provided, satisfactory signals should be obtained within a few hundred feet of low powered mobile transmitters and within several miles of higher powered fixed stations. Depending upon transmitter power, there may be some danger of crystal burn-out if the DM-3 is operated within a few feet of the transmitting antenna.

### 3. POSSIBLE ERRONEOUS READINGS

The DM-3 will give an indication whenever the FM-3, FM-6 or FM-7 fundamental or any harmonic is set 100 kc from an incoming signal. If the transmitter being measured uses frequency multipliers, and some frequency other than the output frequency is coupled with the DM-3, an erroneous reading may be obtained since deviation is multiplied with fre-

quency, and therefore, earlier stages in the multiplier chain operate with less deviation. When the DM-3 is coupled to the radiation field from an antenna of a properly tuned transmitter, this is not likely to cause difficulty since the law requires that transmitters be designed to suppress radiation on other than the assigned output frequency. However, there may be instances when these signals will be fairly strong, such as operation of the DM-3 close to an unshielded transmitter which feeds a distant antenna through shielded line. If such operation is necessary, the possibility of error from this source can be eliminated by choosing an FM-3, FM-6 or FM-7 frequency such that neither the fundamental nor any harmonic will produce an I.F. beat note against any of the frequencies found in the transmitter multiplier chain. Since the FM-3, FM-6 or FM-7 is initially set to zero beat against the signal and then moved 100 kc, the easiest way to accomplish this is to consider the zero beat condition. First, write down all frequencies found in the transmitter multiplier chain. Second, choose an FM-3, FM-6 or FM-7 fundamental frequency which produces a harmonic at the desired transmitter output frequency. Write down the FM-3, FM-6 or FM-7 fundamental frequency and all harmonics up to the transmitter output frequency. If any of these frequencies match the frequencies found in the transmitter multiplier chain, choose another FM-3, FM-6 or FM-7 frequency which will produce a harmonic at the desired output frequency. In general, the number of the harmonic used in the FM-3, FM-6 or FM-7 should contain no factors which are used in the transmitter multiplier chain.

## 4. OPERATING PROCEDURE

To make deviation measurements with the DM-3 proceed according to the following instructions. The first five steps may be carried out either with or without modulation applied to the transmitter as convenient. If continuous modulation is applied during Step 1, a series of beat notes may be heard in the FM-3, FM-6 or FM-7 due to the presence of side bands. As this is only a rough tuning adjustment, it is safe to proceed to Step 2 when this series of beat notes has been located.

A. With the deviation meter power switch OFF connect the INPUT-OUTPUT jack of the frequency meter to the OSC. jack of the deviation meter with the coax cable provided. Connect the signal to be measured to the ANT. jack. Plug headphones into the frequency meter.

B. With the freq. meter function switch in BEAT position, adjust the HF OSC. knob for an approximate zero beat in the phones, using a harmonic of the HFO for frequencies above 40 MC.

C. Rotate the deviation meter function switch to LIMITER CURRENT position and adjust the frequency meter HF OSC. knob for maximum reading. If reading is below red line increase coupling of signal.

D. Rotate deviation meter function switch to FREQ. SET position and adjust frequency meter HF OSC. knob so that the pointer is on the red line.

E. Lock the freq. meter in a manner described in the appropriate instruction book. Re-set the FREQ. SET with the freq. meter LF OSC. if nececssary.

F. Re-check LIMITER CURRENT as in step C.

G. Place the deviation meter range switch in the 7.5 KC or 15 KC position as desired.

H. Rotate the deviation meter function switch to ZERO SET position and adjust the ZERO SET knob for zero meter reading.

I. Rotate the deviation meter function switch to DEVIATION. The peak deviation is now indicated on the meter.

## 5. OPERATION WITH LOCAL OSCILLATOR SOURCES OTHER THAN THE FM-3, FM-6 OR FM-7

Most signal generators or frequency meters which cover the proper frequency range may be used in place of the FM-3, FM-6 or FM-7 as a local oscillator source for the DM-3. To be suitable, a source must be capable of being tuned so that its fundamental or one of its harmonic frequencies falls 100 kc away from the signal to be measured. The source must be stable, free of frequency modulation, and capable of providing sufficient power. If the fundamental frequency of the source can be used to provide a signal 100 kc away from the signal to be measured, a source capable of providing .1 volts across 50 ohms should have sufficient power. If harmonics of the source are to be used, an amplitude of 1.0 V. will probably be sufficient to generate harmonics in the DM-3 mixer crystal. If satisfactory results cannot be obtained, an external harmonic generator circuit such as that shown in Figure 2 may be used. At frequencies much below 20 mc. or much above 1000 mc., larger levels may be required because of attenuation in the DM-3 mixer coupling components. Insufficient local oscillator power will be indicated by low limiter current on the DM-3. If possible, local oscillator power should be increased until no further

increase in limiter current is observed. If the source to be used has no provision for detecting a zero beat, Step B of the DM-3 Operating Procedure may be omitted. In Step C, tune the local oscillator in the vicinity of the signal to be measured until a strong limiter current indication is found. Two indications will be found close together corresponding to high side and low side positions of the local oscillator signal. If other signals are present, headphones should be used to identify the modulation from the signal to be measured. When Step I is reached it is possible to check for frequency modulation on the local oscillator source. To do this turn off the modulation on the transmitter being measured. A reading close to zero should be obtained on the DM-3. Frequency modulation on either the local oscillator or the transmitter being measured will result in indicated deviation on the DM-3.

# SECTION III
# THEORY OF OPERATION

## 1. GENERAL DESCRIPTION

Reference to the block diagram, Figure 3, shows that the DM-3 is essentially a superhetrodyne FM receiver. Energy from a Gertsch Model FM-3, FM-6 or FM-7 Frequency Meter or other suitable source is fed to the mixer where it beats against the signal from the transmitter to be measured. When the FM-3, FM-6 or FM-7 is properly adjusted, a 100 kc I.F. signal containing the original frequency modulation is produced. A three stage I.F. amplifier is provided to build the signal up to a level which will give good limiting. The limiter provides an output signal of precisely known amplitude regardless of amplitude variations in the input signal. The discriminator is of the frequency counter type. This consists of two diodes and a small capacitor. This device transfers a constant amount of charge per cycle through the diodes so that its output is proportional to frequency. The discriminator output current has an AC component which follows the frequency modulation of the transmitter. The relationship is constant regardless of signal strength variations and other extraneous effects as long as proper limiter action is obtained.

The discriminator output current is filtered to remove the 100KC I.F. signal component and fed to an audio amplifier. This amplifier is provided with a large amount of negative feedback to insure its gain will remain constant regardless of variations in transistor parameters or power supply voltages. The output of this amplifier is fed to the phone jack and to a peak reading voltmeter circuit. This circuit rapidly charges a large capacitor to peaks of the modulation wave. The capacitor discharges through a large resistor and the meter movement. This circuit gives accurate indications of peak deviation regardless of the exact wave form used to modulate the transmitter. The fast charge and slow discharge characteristic of this circuit is of value in indicating peak deviation when voice modulation is used. The peak reading voltmeter circuit measures only the amplitude of the negative peak of its input voltage. This gives an indication of deviation on one side only. To measure the other side, it is only necessary to switch the FM-3, FM-6 or FM-7 local oscillator to the other side of the transmitter carrier frequency. This reverses the frequency modulation on the I.F. signal.

## 2. DETAILED CIRCUIT DESCRIPTION

See Schematic Diagram, Figure 4.

### A. MIXER

The mixer consists of a germanium diode sealed in a shielded enclosure with coaxial input and output leads. Tuned circuits are not used since they would complicate construction and operation of the instrument and they are not needed in the type of operation for which this instrument was intended.

### B. I. F. SYSTEM

The mixer is capacitively coupled to the base of X1, the first I.F. amplifier transistor. Two crystal diodes CR2 and CR3, are placed effectively across the tuned circuit consisting of L13 and C4 and in series with the base voltage supply. A similar circuit is used on the input of each of the following transistors. The diodes form a symmetrical limiter which prevents distortion of the I.F. wave form when very large signals are present. Power is fed to the emitters of the I.F. transistors because a negative supply is required in other parts of the instrument. Resistor R3 provides DC degeneration which stabilizes the transistor against changes in the operating point due to temperature variations. Capacitor C6 is used to bypass I.F. frequency currents. The decoupling network consisting of R2 and C5 is used to bring the proper voltage to the base of the transistor. Components L13, R2, C4, C5, CR2, CR3 and C43 are located in the first of a series of four aluminum I.F. cans.

Each transistor is located in the I.F. can with its output transformer. Resistor R4 is used to load the tuned circuit consisting of T2 and C7 to provide suitably broad and stable I.F. band pass characteristics. Capacitor C8 is used to neutralize capacity between base and collector of X1. The second I.F. amplifier stage is identical to the first. Coupling from each I.F. stage to the next is accomplished by means of a step-down transformer which gives a considerable power gain since the base impedance of each transistor is much lower than the collector impedance. The first two transistors each draw about one ma. of current from the -5.2 volt line. The output I.F. amplifier X3 draws about two ma. from the -5.2 volt line. In addition a +1.4 volt supply is connected to the collector circuit of this transistor. These changes are necessary so that this transistor can supply sufficient power to drive the limiter. The limiter is coupled to the collector circuit of the transistor by means of R11 and C18. The secondary of transformer T4 is used only for neutralizing. No load resistor is necessary across the primary of T4 because the limiter stage provides sufficient loading in normal operation.

C. LIMITER

The limiter stage consists of two germanium diodes, CR8 and CR9, which are connected in series from ground to the -4 volt supply. They are connected in the back direction across this supply. When the L.F. signal is applied to this circuit it forms a square wave of slightly greater than 4 volts peak to peak amplitude. Resistor R12 is placed in the ground end of the limiter circuit to allow measurement of the limiter current to insure adequate limiting. This resistor is shorted by the meter switch in positions where it would introduce an error. The resistor is made of copper wire to match the temperature coefficent of the meter movement.

D. DISCRIMINATOR

The discriminator used in the DM-3 is one of the frequency counter type. It consists of an adjustable capacity formed of C21 and C22 in parallel and two diodes, CR10 and CR11. The input to this circuit is a square wave of constant amplitude determined by the limiter. On the positive half cycle of the square wave charge flows from the capacity through CR10. On the negative half cycle the same amount of charge flows back into the capacity through CR11. The quantity of charge transferred per cycle is given by the formula $Q = CE$ where C is the total capacity of C21 and C22 and E is the peak to peak voltage change across the capacity. If the circuit is designed so that the output voltage is small compared to the input, E is determined almost entirely by the amplitude of the wave from the limiter. This circuit, therefore, transfers a constant amount of charge per cycle. Current, which is the rate of flow of charge per unit time, is therefore proportional to the frequency of the input wave. Calibration of this circuit is accomplished by adjusting C22. The current through the counter can be considered to consist of several components. A DC component proportional to the I.F. frequency, an audio frequency component proportional to the frequency modulation of the I.F., and several components of the I.F. frequency and harmonics thereof. In the frequency set position of the meter switch, the meter movement is placed across R37, a temperature compensating copper wire wound meter shunt. The I.F. frequency is tuned to exactly 100 kc by means of this indication. The audio and I.F. frequency components are passed through the filter which rejects the I.F. and harmonic frequencies to prevent errors in measurement.

E. FILTER

The filter is designed to have a cut-off frequency of 50 kc. This allows adequate rejection of the I.F. frequency and its harmonics without introducting serious amplitude or phase error in the normal voice frequency range. Phase error is important in this application since peak deviation is to be measured, and the peak value of a wave can be altered by shifting the phase of harmonics with respect to the fundamental.

F. AUDIO AMPLIFIER

A three stage audio amplifier consisting of transisors X4, X5 and X6 is used. This amplifier is direct coupled. Batteries BA1 and BA2 are used as constant voltage coupling devices. Two separate degenerative feedback paths are provided. Resistor R19 provides degenerative feedback in the audio frequency range which greatly reduces the distortion of the amplifier and stabilizes the gain regardless of large variations in transistor parameters. A separate DC degenerative feedback path is provided to stabilize the operating point of the transistors. A 20.3V source supplies negative collector voltage to X6, the output transistor. The positive end is referenced to ground through R29 which developes a voltage proportional to the current through the output transistor. A filter consisting of C37, C38, C39, C46, R30 and R31 is used to remove audio frequency components from this voltage. The output of this filter is fed back through R14 and R18 to the base of V4, the first audio transistor. This provides a very large degenerative feedback at DC and very low frequencies, which effectively stabilizes the amplifier against changes in operating potentials due to temperature effects or variations in transistor parameters. The DC feedback filter is designed to have an amplitude and phase characteristic which will make the amplifier stable

at low frequencies. To give satisfactory high frequency stability, a lead capacitor, C29, is connected in parallel with R19, and three step networks consisting of C30 and R20, C31 and R21, and C32 and R24, are used. Resistor R28 is inserted in series with the output collector supply to develop a signal suitable for driving headphones. Capacitor C36 is used to block DC from the headphone circuit.

G. PEAK READING VOLTMETER

Audio frequency voltage is coupled from the collector of X6 through C33 and R35 to the base of X7, the peak voltmeter transistor. This transistor conducts only on the negative peak of the input wave. Capacitor C35 is charged through X7 until the emitter reaches a DC potential which is approximately equal to the negative peak of the wave on the base of the transistor. The negative voltage on the emitter is measured by means of R27 and M12. This provides a long time constant discharge path for C35, and allows accurate measurement of relatively narrow peaks of audio voltage. Capacitor C34 is used to bypass the collector of X7. A current is fed to the meter movement through R33 and R34, the zero set control. This is used to compensate for current leakage through X7. This leakage current varies with temperature and must be cancelled to obtain accurate readings.

H. METER CIRCUITS

A meter switch is provided so that the meter movement can serve several functions. In the limiter current position, the meter movement measures current flowing to the limiter diodes. This is used for a rough tuning indication, and to check signal strength in order to be sure accurate deviation readings will be obtained. In the frequency set, zero, and deviation positions, R12, the meter shunt used for limiter current measurements, is shorted to ground by another section of the meter switch. In the Frequency Set position, the meter is switched across R13 which serves as a suitable shunt to measure the DC component of discrminator current. This allows the local oscillator to be tund so that the I.F. frequency is exactly 100 kc and proper I.F. band pass characteristics are obtained. If the local oscillator is not correctly tuned large errors in deviation measurement can result because of the large amplitude modulation of the I.F. output which occurs when the frequency swings out of the normal I.F. pass band. In the Zero Set position, the I.F. wave form at the limiter is shorted to ground by another section of the meter switch. This removes the audio signal from the audio amplifier and peak voltmeter and allows the zero set adjustment to be made. In the zero and deviation positions, the meter movement is connected through a 100K multiplier resistor, R27, to the emitter of the peak voltmeter transistor. In the 7.5 kc position of the selector switch this resistor is shunted by R40, a variable resistor, to provide full scale deflection with 7.5 kc deviation.

# SECTION IV
# MAINTENANCE

1. CALIBRATION

To calibrate the DM-3, a transmitter or signal generator having a precisely known FM deviation must be used. The deviation indicating meter or dial calibration on a signal generator should not be relied on as these indications are usually not precise, and a considerable error could result if the sensitivity of the modulator used in the signal generator should change. The carrier null method may be used to adjust any FM signal generator or any available FM transmitter to a precisely known deviation. To do this a sinusoidal audio frequency oscillator having continuously variable output amplitude should be used to modulate the FM signal generator or transmitter. If a transmitter is used, modulation limiters must be set to allow more than 15 kc deviation. The procedure is as follows:

A. Set the audio frequency oscillator to 1.733 kc. This frequency should be set within $\pm 1\%$ as accuracy depends upon it.

B. Connect the audio frequency oscillator to the signal generator or transmitter and turn the audio frequency amplitude to zero.

C. Set up the Gertsch FM-3, FM-6 or FM-7 or other heterodyne frequency meter and find a beat note against the carrier of the FM signal generator or transmitter. Adjust for a beat note at a low but clearly audible frequency. A beat note of 200-300 cps should give satisfactory results.

D. While listening to the beat note in the FM-3, FM-6 or FM-7, turn up the amplitude control of the audio frequency oscillator to cause FM deviation. Distinct points will be found where the beat note against the carrier disappears. Other beat notes against side band frequencies will be heard in the phones, but these can easily be ignored if the beat note against the carrier is properly chosen. Turn up the amplitude control slowly until the third carrier disappearance is reached. Adjust carefully to center it in the range where the carrier is inaudible.

E. A signal which is frequency modulated 15 kc is now available for calibration of the DM-3.

Remove the DM-3 from its case. Locate the trimmer capacitor on the back of the DM-3. Before turning on power to the DM-3, carefully mechanically zero the meter movement. When doing this the DM-3 should be held in a vertical position if it is to be used in a vertical position. Carefully follow the operating procedure for the DM-3 to measure the deviation of the calibrated source. When the DM-3 meter switch is in the deviation position, adjust the trimmer capacitor to obtain a reading of exactly 15. Switch back to the frequency set position and retune the local oscillator, if necessary, to bring the meter exactly to the red line. Recheck the deviation reading and adjust if necessary. Now move the local oscillator to the opposite side of the signal and follow the DM-3 operating procedure again. This will measure the opposite peak of deviation of the calibrated source. If any difference is noticed it is probably due to nonlinear modulation in the transmitter. If the discrepancy is small, adjust the DM-3 calibration trimmer to remove ½ of the remaining error. If the difference is greater than about 5% of full scale, a more satisfactory signal source should be found.

F. Repeat steps A through E with an audio frequency of 866.7 cps and adjust R40 for full scale deflection with the range switch in the 7.5 kc position.

## 3. TROUBLE SHOOTING

Transistor leads can be identified by the spacing of the holes where they are brought through the terminal boards. The center lead is in the base of the transistor. The outside lead closest to the base lead is the emitter. The lead base farthest from the base lead is the collector. If no audio output can be heard when phones are plugged into the DM-3, voltage in the audio amplifier should be checked.

The audio amplifier consisting of X4, X5 and X6 is direct coupled with degenerative feedback and a fault in any one of these stages will affect the voltages in all three stages. The voltage at the collector of X6 should be checked first. This should be 11-13 volts. If a serious fault is present in the amplifier, this voltage will usually either be close to zero or close to the negative supply voltage. Terminal voltages of the other transistors should be checked in an effort to determine the faulty component. If a transistor is suspected, two of its leads can be unwrapped from terminals on the board and another transistor substituted by connecting its three leads to the appropriate terminals. If this remedies the condition, the defective transistor should be replaced. To do this the terminal board may be lifted by removing the four screws holding it.

If the meter cannot be adjusted to zero in the zero set position, or if it drifts up the scale, check the action of the zero set control. If the zero set control has no effect on meter position, failure of the 2.2 volt supply or some fault in the zero set circuit should be suspected. If the zero set control is capable of moving the meter through a considerable range but cannot return it to zero, or if the meter drifts up the scale, excessive leakage current through X7, the voltmeter transistor is the probable cause. Two terminals of this transistor can be disconnected and another transistor substituted to check this. If possible the transistor to be substituted should first be tested for low leakage current. All cables are dressed so that they may be folded back for servicing. Excessive flexing of the cable should be avoided since failure may result due to fatigue in the copper wires.

The limiter current and frequency set positions of the meter switch may be used to roughly locate a trouble. If proper indications are obtained in these positions but no audio output or deviation reading are obtained, the fault must lie in the audio amplifier or the filter. A resistance check on the filter should show about 250 ohms from one end to the other. A reading of several thousand ohms would indicate an open filter choke. An extremely high reading in the limiter current or frequency set position could be caused by the failure of one of the meter shunt resistors, R12 or R13. If no limiter current or frequency set indications are obtained, the trouble is probably in the mixer or I.F. system. The I.F. output can be checked with an oscilloscope by locating the lead which comes from the last I.F. can to R11, a 1 k resistor. If necessary, the entire I.F. strip may be slid out of the instrument by removing two screws on the front panel. If the screw holding the ground leads to the I.F. mounting bracket is removed the clips holding the various I.F. transformers in their cans can be squeezed to release the transformers, and the entire I.F. stages can be removed from their cans. Coil continuities and resistance values in the I.F. cans can easily be checked. Voltage readings made with the I.F. stage outside their cans may not be reliable since the I.F. amplifier may oscillate. With the I.F. transformers replaced in their cans and properly grounded to the mounting bracket and on the frame of the DM-3, voltage and signal checks at the bottom terminals of the I.F. stages may be made. If desired, a 100 kc signal may be injected in the FM-3 jack on the front panel of the DM-3 to provide an I.F. test signal. Several volts will be required to overcome the attenuation of the mixer which is not designed for efficient transfer of such low frequencies. If the mixer is found to be nonoperative due to crystal burnout or some other fault, the entire mixer unit should be replaced with a new one obtained from Gertsch Products, Inc.

# SECTION V
# PARTS LIST

| Symbol | Description | Manufacturer & Designation |
|---|---|---|
| | All Resistors are fixed, composition, ±10% tolerance, ½ W. unless otherwise specified. | |
| R1 | 47 ohms | |
| R2 | 1.5 K | |
| R3 | 1 K | |
| R4 | 8.2 K | |
| R5 | 1.5 K | |
| R6 | 1 K | |
| R7 | 8.2 K | |
| R8 | 1.5 K | |
| R9 | 470 ohms | |
| R10 | 150 ohms | |
| R11 | 1 K | |
| R12 | Resistor: fixed, wire wound, temperature compensating 47.5 ohms ±2% | GPI No. RW-1 |
| R13 | Resistor: fixed, wire wound, temperature compensating 311.5 ohms ±2% | GPI No. RW-2 |
| R14 | Resistor: fixed, metal film 1 K ±1%, ½ W. | Continental Carbon Inc. Type NA 15 |
| R15 | 1 K | |
| R16 | 1 K | |
| R17 | Resistor: fixed, metal film 820 ohms ±1%, ½ W. | Continental Carbon Inc. Type NA 15 |
| R18 | 3.3 K | |
| R19 | Resistor: fixed, metal film 680 K ±1%, ½W. | Continental Carbon Inc. Type NA 15 |
| R20 | 680 ohms | |
| R21 | 1 K | |
| R22 | 5.6 K | |
| R23 | 4.7 K | |
| R24 | 2.2 K | |
| R25 | 5.6 K | |
| R26 | 10 K | |
| R27 | Resistor: fixed, metal film 100 K ±1% | Continental Carbon Inc. Type NA 15 |
| R28 | 470 ohms | |
| R29 | 820 ohms ±5% | |
| R30 | 2.2 K | |
| R31 | 27 ohms | |
| R33 | 47 K | |
| R34 | Resistor: variable, composition, 10 K | Chicago Telephone Supply No. BB2428 |
| R35 | 22 K | |
| R36 | Resistor: fixed, wire wound, temperature compensating. Value selected at factory. | GPI No. RW-3 |
| R37 | Resistor: fixed, composition, ½ W. Value selected at factory. | |
| R38 | 150 ohms | |
| R39 | 3.9 K | |
| R40 | Resistor: variable 150 K | Bourns Type 120 |
| C1 | Capacitor: ceramic disc, 27 uuf. ±20%, 600 VDCW | Cornell Dublier Type GO27 |
| C2 | Capacitor: ceramic disc, 27 uuf. ±20% 600 VDCW | Cornell Dublier Type GO27 |
| C3 | Capacitor: tubular ceramic 100 uuf. ±20%, 350 VDCW | Erie GPI A 100 ± 20 |
| C4 | Capacitor: silvered mica 220 uuf. ±5%, 500 VDCW | Type CM15E221J |
| C5 | Capacitor: ceramic .05 uf. −20% +80% 75 VDCW | Gulton |
| C6 | Capacitor: electrolytic 2 uf. −20% +60%, 6 VDCW | Barco Type PT-6-2 |
| C7 | Capacitor: silvered mica 220 uuf. ±5%, 500 VDCW | Type CM15E221J |
| C8 | Capacitor: disc ceramic, N-330 20* uuf. ±10%, 600 VDCW | Erie Type 831 |
| C9 | Capacitor: ceramic .05 uf. −20% +80% 75 VDCW | Gulton |
| C10 | Capacitor: electrolytic 2 uf. −20% +60%, 6 VDCW | Barco Type PT 6-2 |

| Symbol | Description | Manufacturer & Designation |
|---|---|---|
| C11 | Capacitor: silvered mica, 220 uuf. ±5%, 500 VDCW | Type CM15E221J |
| C12 | Capacitor: disc ceramic, N-330 20* uuf. ±10%, 600 VDCW | Erie Type 831 |
| C13 | Capacitor: ceramic .05 uf. −20% +80% 75 VDCW | Gulton |
| C14 | Capacitor: electrolytic 2 uf. −20% +60%, VDCW | Barco Type PT 6-2 |
| C15 | Capacitor: silvered mica 55 uuf ±5%, 500 VDCW | Type CM15E550J |
| C16 | Capacitor: disc ceramic, N-330 20* uuf ± 10%, 600 VDCW | Erie Type 831 |
| C17 | Capacitor: electrolytic, 2 uf. −20% +60%, 6 VDCW | Barco Type PT 6-2 |
| C18 | Capacitor: disc ceramic, .01 uf. −0 +100%, 500 VDCW | Erie Type 811 |
| C19 | Capacitor: electrolytic, 2 uf. −20%, +60%, 6 VDCW | Barco Type PT 6-2 |
| C20 | Capacitor: ceramic, .05 uf. −20%, +80%, 75 VDCW | Gulton |
| C21 | Capacitor: silvered mica, 240 uuf. ±20%, 500 VDCW | Type CM15E241G |
| C22 | Capacitor: variable, ceramic, N500, 7-45 uuf. | Erie TS2A-7 |
| C23 | Capacitor: fixed, ceramic, .05 uf. −20% +80%, 75 VDCW | Gulton |
| C24 | Capacitor: fixed, ceramic, .0043 uf. ±5% | ARCO DM-20-432-J |
| C25 | Capacitor: fixed, ceramic, .0082 uf. ±5% | ARCO DM-20-822-J |
| C26 | Capacitor: fixed, ceramic, .0082 uf. ±5% | ARCO DM-20-822-J |
| C27 | Capacitor: fixed, ceramic, .0082 uf. ±5% | ARCO DM-20-822-J |
| C28 | Capacitor: fixed, ceramic, .0043 uf. ±5% | ARCO DM-20-432-J |
| C29 | Capacitor: fixed, disc ceramic, NPO, 4.7 uuf. ±10%, 600 VDCW | Erie Type 831 |
| C30 | Capacitor: fixed, disc ceramic, .005 uf. −0 +100%, 500 VDCW | Erie Type 811 |
| C31 | Capacitor: fixed, disc ceramic, .005 uf. −0 +100% , 500 VDCW | Erie Type 811 |
| C32 | Capacitor: fixed, disc ceramic, 1500 uuf. −0 +100%, 500 VDCW | Erie Type 801 |
| C33 | Capacitor: fixed, electrolytic, 8uf. −20% +60%, 25 VDCW | Barco Type P25-8I |
| C34 | Capacitor: fixed, electrolytic, 8 uf. −20% +60%, 25 VDCW | Barco Type P25-8I |
| C35 | Capacitor: fixed, electrolytic, 8 uf. −20% +60%, 25 VDCW | Barco Type P25-8I |
| C36 | Capacitor: fixed, electrolytic, 40 uf. −20% +60%, 3 VDCW | Barco Type P3-40I |
| C37 | Capacitor: fixed, electrolytic, 100 uf. −20% +60%, 3 VDCW | Barco Type P3-100I |
| C38 | Capacitor: fixed, electrolytic, 100 uf. −20% +60% 3 VDCW | Barco Type P3-100I |
| C39 | Capacitor: fixed, electrolytic, 100 uf. −20% +60%, 3 VDCW | Barco Type P3-100I |
| C40 | Capacitor: fixed, disc ceramic, .01 uf. −0 +100%, 500 VDCW | Erie Type 811 |

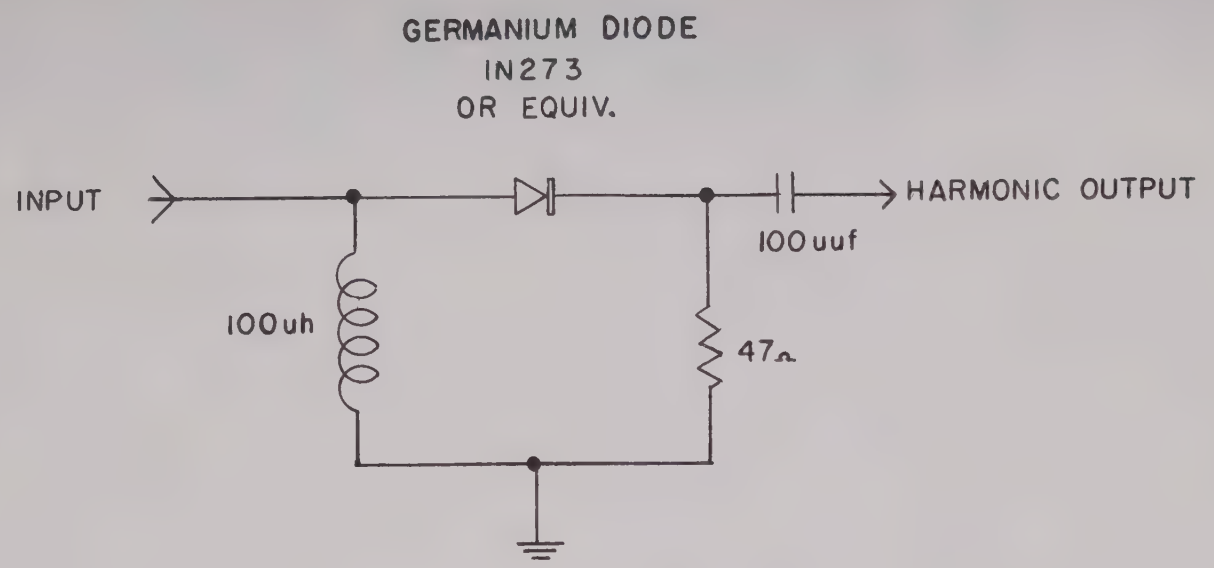
* Average value shown — may be adjusted at factory

| Symbol | Description | Manufacturer & Designation |
|---|---|---|
| C41 | Capacitor: fixed, disc ceramic, .01 uf. −0 +100%, 500 VDCW | Erie Type 811 |
| C42 | Capacitor: fixed, electrolytic, 100 uf. −20% +60%, 3 VDCW | Barco Type P3-100I |
| C44 | Capacitor: fixed, electrolytic, 100 uf. −20% +60%, 3 VDCW | Barco Type P3-100I |
| C45 | Capacitor: fixed, electrolytic, 100 uf. −20% +60%, 3 VDCW | Barco Type P3-100I |
| C46 | Capacitor: fixed, electrolytic, 100 uf. −20% +60%, 3 VDCW | Barco Type P3-100I |
| C47 | Capacitor: fixed, electrolytic, 5 mfd −20% +60%, 40 VDCW | Barco Type P40-5I |
| C48 | Capacitor: fixed, electrolytic 5 mfd −20% +60%, 40 VDCW | Barco Type P40-5I |
| C49 | Capacitor: fixed, electrolytic 5 mfd −20% +60%, 40 VDCW | Barco Type P40-5I |
| C50 | Capacitor: fixed, electrolytic 8 mfd −20% +60%, 25 VDCW | Barco Type P25-8I |
| C51 | Capacitor: fixed, electrolytic 8 mfd −20% +60%, 25 VDCW | Barco Type P25-8I |
| C52 | Capacitor: fixed, electrolytic 15 mfd, 15 VDCW | Fansteel P15B15A2 |
| L1 | Inductor: R.F. choke 1 uh | GPI No. LS-8 |
| L2 | Inductor: R.F. choke 0.1 uh | GPI No. LS-9 |
| L3 | Inductor: R.F. choke 10 uh | National Type R33 |
| L4 | Inductor: filter choke 2.5 mh | GPI No. LS-6 |
| L5 | Inductor: filter choke 2.5 mh | GPI No. LS-6 |
| L6 | Inductor: filter choke 5.0 mh | GPI No. LS-7 |
| L7 | Inductor: filter choke 5.0 mh | GPI No. LS-7 |
| L8 | Inductor: filter choke 2.5 mh | GPI No. LS-6 |
| L9 | Inductor: filter choke 2.5 mh | GPI No. LS-6 |
| L10 | Inductor: R.F. choke 10 uh | National Type R33 |
| L11 | Inductor: R.F. choke 10 uh | National Type R33 |
| L12 | Inductor: R.F. choke 1 uh | GPI No. LS-8 |
| L13 | Inductor: I.F. Input | GPI No. LS-2 |
| T1 | Transformer: Power | GPI No. TP-5 |
| T2 | Transformer: I.F. Interstage | GPI No. LS-3 |
| T3 | Transformer: I.F. Interstage | GPI No. LS-3 |
| T4 | Transformer: I.F. Interstage | GPI No. LS-3 |
| M1 | Meter Movement 0-50 Microamperes | Triplett 421-A Special Scale GPI No. NP-1 |
| SW1 | Switch, Function | GPI No. SW-30 |
| SW2 | Switch, Toggle | Carling No. 112-73 |
| F1 | Fuse, 3 AG 1/8 Amp. | |
| CR-1 | Crystal Diode: Type IN82A | Sylvania |
| CR-2 | Crystal Diode: Type IN95 | Hughes |
| CR-3 | Crystal Diode: Type IN95 | Hughes |
| CR-4 | Crystal Diode: Type IN95 | Hughes |
| CR-5 | Crystal Diode: Type IN95 | Hughes |
| CR-6 | Crystal Diode: Type IN95 | Hughes |
| CR-7 | Crystal Diode: Type IN95 | Hughes |
| CR-8 | Crystal Diode: Type IN273 | Transitron |
| CR-9 | Crystal Diode: Type IN273 | Transitron |
| CR-10 | Crystal Diode: Type IN273 | Transitron |
| CR-11 | Crystal Diode: Type IN273 | Transitron |
| CR-12 | Crystal Diode: Type IN457 | Hughes |
| CR-13 | Crystal Diode: Type IN457 | Hughes |

| Symbol | Description | Manufacturer & Designation |
|---|---|---|
| CR-14 | Crystal Diode: Type IN457 | Hughes |
| CR-15 | Crystal Diode: Type IN457 | Hughes |
| CR-16 | Crystal Diode: Type IN457 or Type IN95 | Hughes |
| CR-17 | Crystal Diode: Type IN457 or Type IN95 | Hughes |
| CR-18 | Crystal Diode: Type IN457 or Type IN95 | Hughes |
| CR-19 | Crystal Diode: Type IN457 or Type IN95 | Hughes |
| CR-20 | Crystal Diode: Type IN457 or Type IN95 | Hughes |
| CR-21 | Crystal Diode: Type IN457 or Type IN95 | Hughes |
| CR-22 | Crystal Diode: Type IN457 or Type IN95 | Hughes |
| CR-23 | Crystal Diode: Type IN457 or Type IN95 | Hughes |
| CR-24 | Crystal Diode: Type IN205 22.5V | Hoffman |
| CR-25 | Crystal Diode: Type IN475A 6.6V ±5% | Hoffman |
| X1 | Transistor: Type 2N78 | G. E. |
| X2 | Transistor: Type 2N78 | G. E. |
| X3 | Transistor: Type 2N78 | G. E. |
| X4 | Transistor: Type 2N43 | G. E. |
| X5 | Transistor: Type 2N43 | G. E. |
| X6 | Transistor: Type 2N43 | G. E. |
| X7 | Transistor: Type 2N43 | G. E. |
| BA-1 | Battery: Mercury, 1.3 V | Mallory RM 625RT2 |
| BA-2 | Battery: Mercury, 1.3 V | Mallory RM 625RT2 |

SUBSTITUTIONS

When necessary, parts may be substituted at the factory. Performance will not be impaired. For replacement purposes, either the part specified in the parts list or the substitute part may be used.




DIODE HARMONIC GENERATOR
WILL PRODUCE USEFUL HARM.
UP TO 1000 MC FROM 20-40 MC.
INPUT WITH 1.0 VOLT INPUT
AMPLITUDE

FIGURE 2 — SUGGESTED HARMONIC GENERATOR CIRCUIT

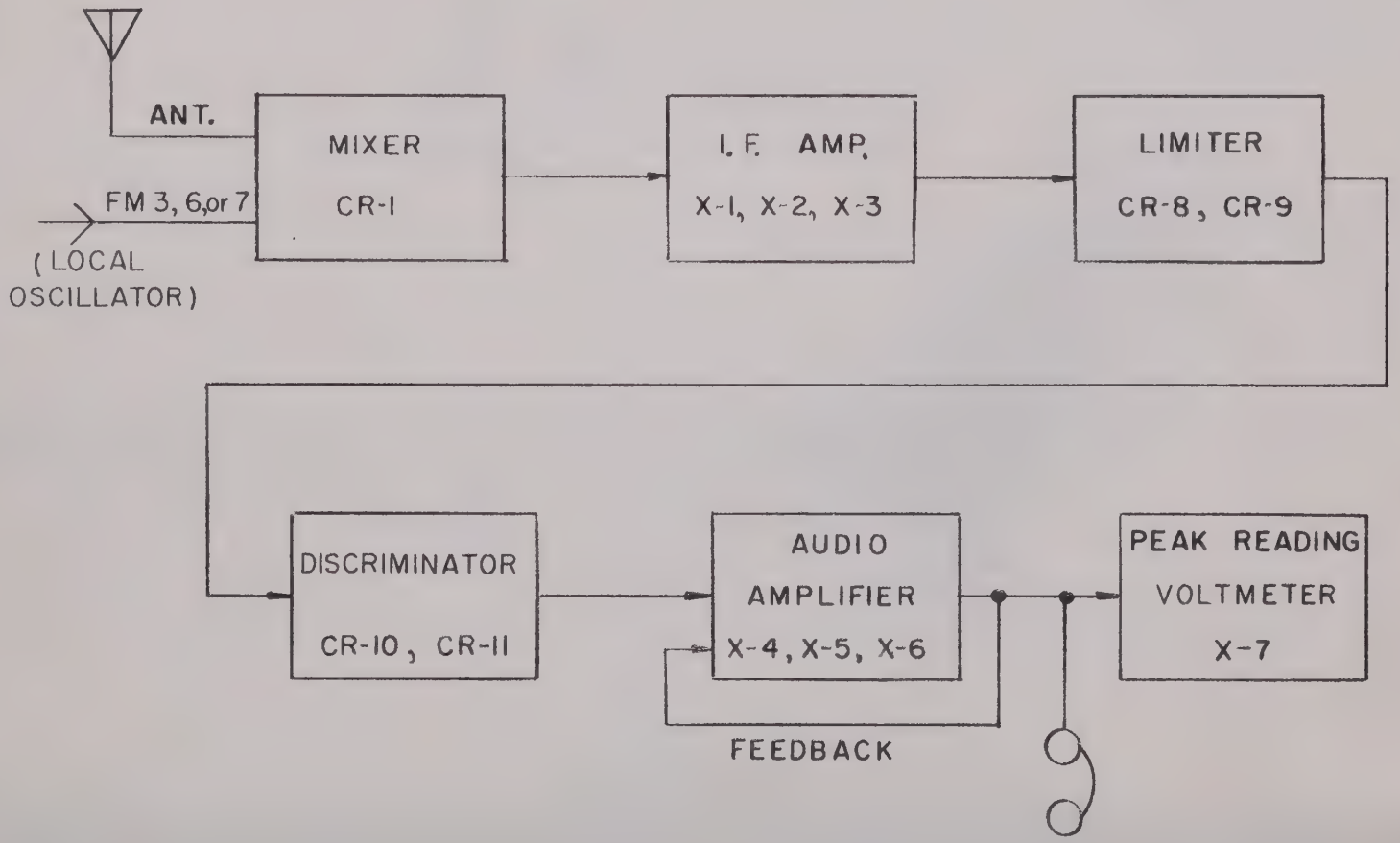
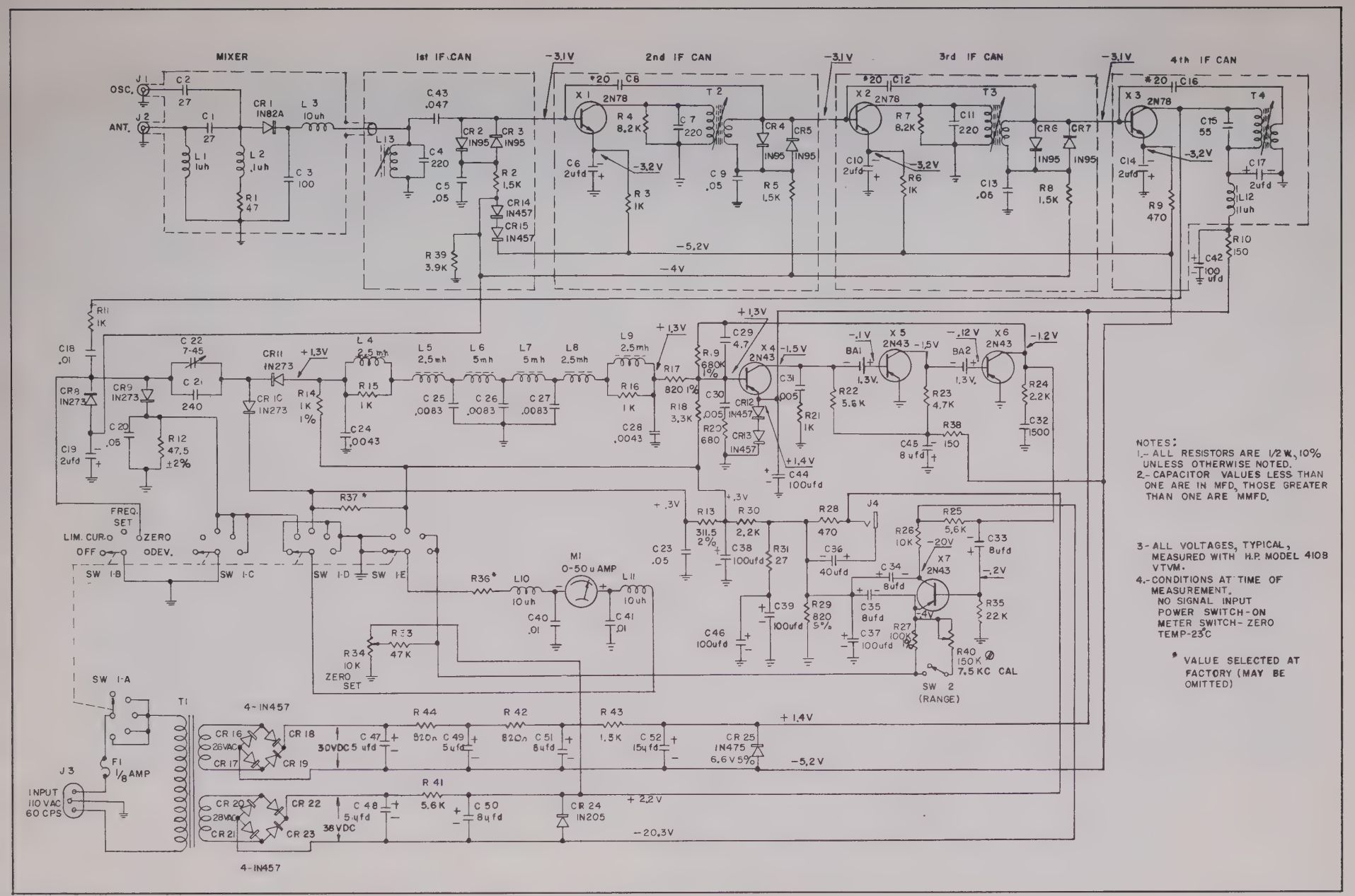



FIGURE 3 — DM-3 BLOCK DIAGRAM




NOTES:
1.- ALL RESISTORS ARE 1/2 W, 10% UNLESS OTHERWISE NOTED.
2.- CAPACITOR VALUES LESS THAN ONE ARE IN MFD, THOSE GREATER THAN ONE ARE MMFD.

3 - ALL VOLTAGES, TYPICAL, MEASURED WITH H.P. MODEL 410B VTVM.

4.- CONDITIONS AT TIME OF MEASUREMENT.
NO SIGNAL INPUT
POWER SWITCH - ON
METER SWITCH - ZERO
TEMP - 25°C

* VALUE SELECTED AT FACTORY (MAY BE OMITTED)

FIGURE 4 — SCHEMATIC DIAGRAM

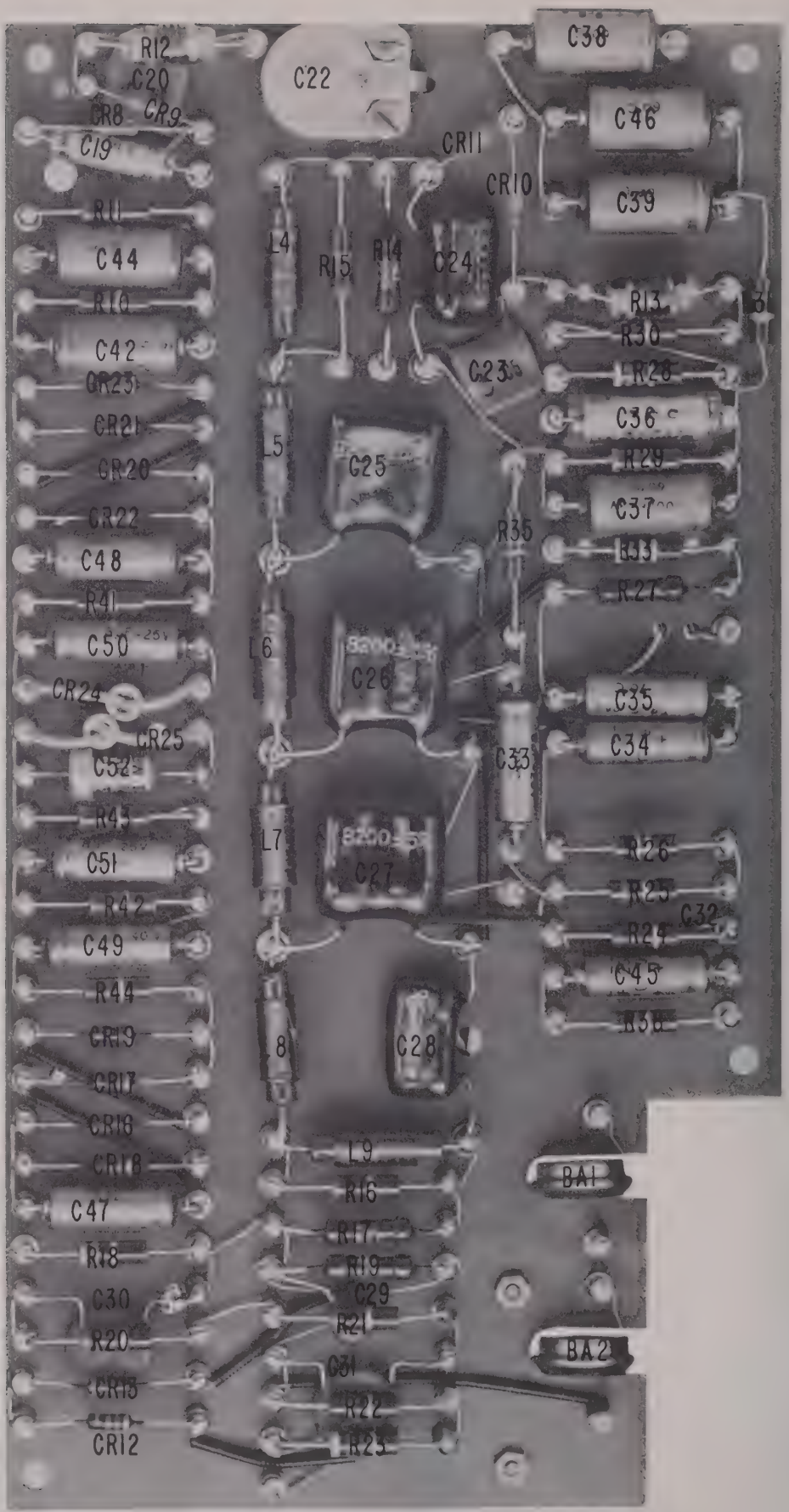



FIGURE 5 — TERMINAL BOARD, DM-3

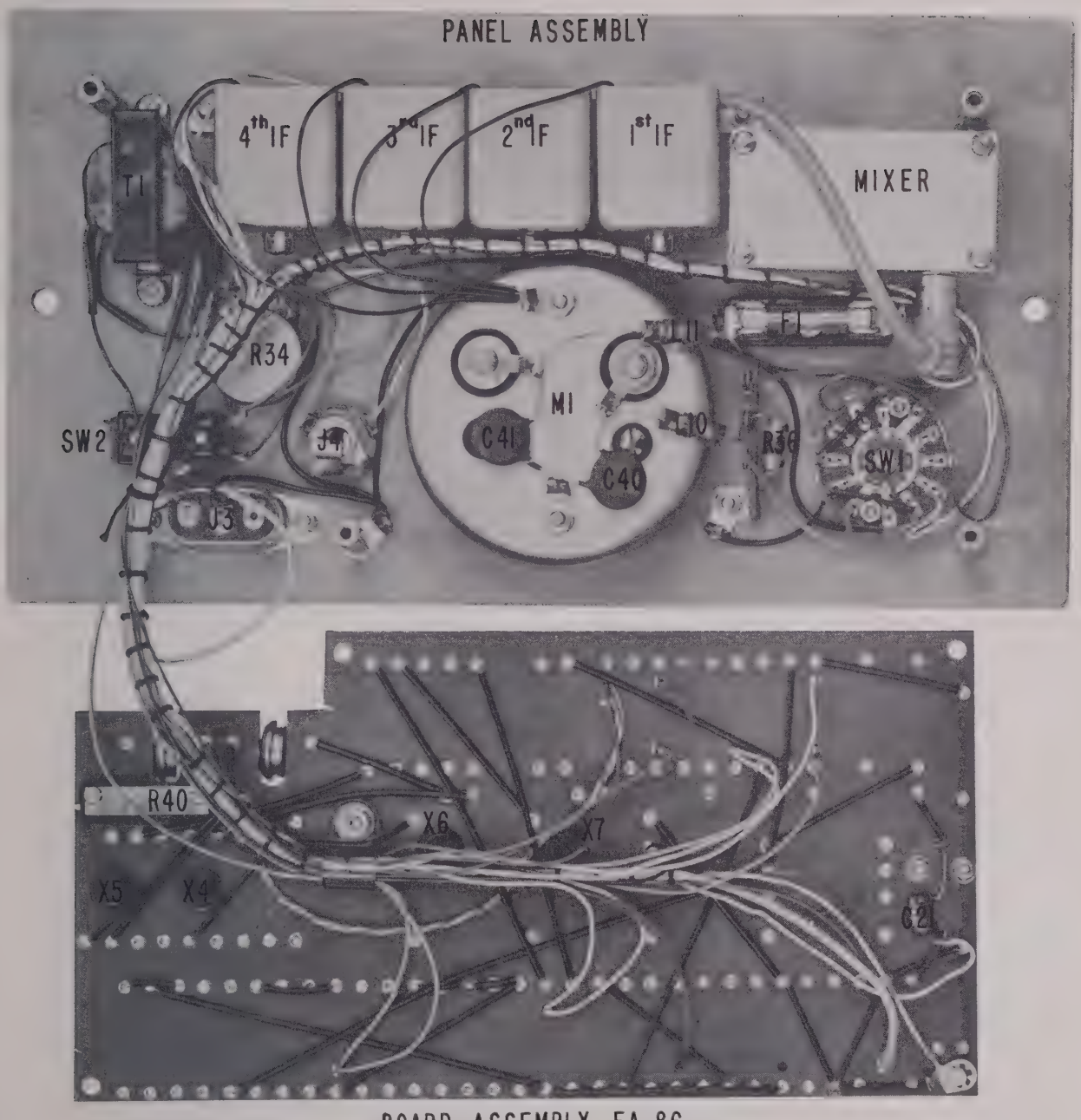



FIGURE 6 — COMPONENT LAYOUT, DM-3

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